Motion-preserving wrist reconstruction using a microsurgical medial femur condylus bone graft and radio-scapho-lunate (RSL) limited fusion after osteomyelitis following open distal radius fracture

Abstract

This case presents the microsurgical management in the rare situation after sequestering osteomyelitis of the distal radius to achieve both bony stability and partially preserved wrist motion. A 38-year-old patient underwent after sequestrectomy microsurgical reconstruction using a medial femoral condyle as a prerequisite for simultaneous motion-preserving radio-scapho-lunate (RSL) fusion. As a result, 11 months postoperatively, a good functional result was achieved with range of motion of 60° in extension/flexion and 40° in ulnar/radial deviation and grip strength of 12 kg corresponding to 33% of the dominant contralateral side. Upper extremity usability as measured by Disability of Arm Shoulder and Hand (DASH) questionnaire improved from preoperative 24 to 8 points after the reconstruction and enabled the patient to resume his work without pain.

Keywords: upper extremity, osteoarthritis, reconstructive surgical procedures, microsurgery, arthrodesis

Zusammenfassung


Schlüsselwörter: obere Extremität, Arthrose, plastische Rekonstruktion, Mikrochirurgie, Arthrodese
Introduction

Deep bony infections of the distal radius are rare, but difficult to treat, mostly occurring after open fractures or complicated osteosyntheses. Even with a defect size of less than 4 cm, they usually require reconstruction using vascularized bone grafts [1]. At least partial preservation of wrist range of motion is desirable.

Case report

A 38-year-old patient complained of increasing load-dependent pain of his left nondominant wrist. Medical history revealed a polytrauma (motorcycle accident) with first degree open intra-articular distal radius fracture which was treated initially by external fixation followed by open reduction and plate fixation 10 years ago. Due to delayed bony consolidation and malunion, corrective osteotomy and re-osteosynthesis by plate with iliac crest bone grafting was performed 8 months later. Due to infection partial implant removal was conducted 3 months later. Finally 7 years ago implant material was completely removed.

Clinical examination showed tenderness over the radiocarpal joint with severe increase of complaints during motion and strain. Range of motion of the left wrist was considerably impaired (Table 1).

<table>
<thead>
<tr>
<th>Table 1: Pre- und postoperative clinical parameter</th>
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</thead>
<tbody>
<tr>
<td>Clinical parameters</td>
</tr>
<tr>
<td>Wrist range of motion</td>
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<td>– extension/flexion</td>
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<td>– ulnar/radial deviation</td>
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<td>Grasp strength (Jamar)</td>
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<td>Pain (visual analogue scale)</td>
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<td>– at rest (0–10)</td>
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<td>– during heavy strain (0–10)</td>
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<td>Disability of Arm, Shoulder and Hand (DASH) questionnaire</td>
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Radiographically, marked osteoarthritis of the radiocarpal joint was shown, yet the structure of the mediocarpal joint was unaffected. On the CT scan, a large bone defect was visible with sequestration of the non-vascularized iliac crest interposition graft (Figure 1).

After sequestrectomy microsurgical transplantation of vascularized bone block from the medial femoral condyle was conducted.

The bone graft was harvested from the right contralateral leg to facilitate the simultaneous work of two operative teams (Figure 2).

A palmar approach was used to reach the bony defect, as it was larger at this side, while the microvascular anastomosis was performed through an extra incision on the radio-dorsal part of the wrist. A small additional dorsal approach was used to cut the dorsal interosseous nerve for partial wrist denervation.

Figure 1: Large bony defect of the distal radius due to deep infection and iliac bone graft sequester and complete destruction of the radiocarpal joint surface.

Figure 2: Harvest of medial femoral condyle perfused by the descending genicular artery (prior to microsurgical transplantation)

The graft was harvested with his artery and two veins and anastomosed using an end-to-side technique to the dorsal branch of the radial artery. Both veins were connected freehand without vein-coupler to two local subcutaneous veins.

The proportions of the graft after trimming to fit were 15x16x21 mm.

We used a press fit technique instead of a screw to fixate the bone graft not to endanger the vitality of the graft by drilling and placing a screw.

Finally the operation was combined with RSL fusion (Medartis RSL plate 2.5 mm) of the left wrist to preserve partial motion (Figure 3).

After 8 weeks of immobilization in a forearm plaster, intensive hand therapy was started. Currently, 11 months postoperatively, the patient is asymptomatic at rest and has mild pain under load, grip strength of 12 kg corresponds to 33% of the dominant opposite side (Figure 4). No complications occurred at the donor site.
Discussion

Deep bony infections of the distal radius bone infections are rare, risk factors include open fractures, fixation with K-wires, external fixation systems and multiple interventions – as in this case [2]. The bony defect required reconstruction and purely symptomatic therapy with orthosis, analgesics administration, cortisone infiltration or surgical denervation was precluded, also regarding comitant severe wrist osteoarthritis. Due to poor blood supply, use of allogenic bone was not recommandable. The patient refused to endoprosthetic joint replacement. Treatment goals included removal of devitalized bone, stable bony reconstruction and preservation of a partial range of wrist motion. However, arthrodesis between radius, scaphoid and lunate required a vital bone fundament. Re-grafting using autologous non-vascularized bone (e.g. taken from iliac crest of the opposite side, rib or scapula) did not appear promising due to poor perfusion locally. Local pediced vascularized bone grafts from the radius itself have the advantage that they can be transferred into the bone defect without microsurgical anastomosis [3]. However, pedicle length and the size of the defect were limiting factors here as also the likely destruction of the supplying vessels during multiple previous surgeries for primary osteosynthesis, corrective osteotomy, bone block transfers, debridement of deep bone type infection and metal removal.

Consequently, our favored solution was microsurgical bone transplantation using the medial femoral condyle supplied by the descending genularis artery. This donor site was originally described by Hertel and Masquelet (1989) for local pedicled osteo-periosteal tibial bone reconstruction [4], before microsurgical transplantation described by Sakai et al. was established [5]. Main indications include above all malperfused nonunions, especially of the scaphoid with humpback deformity and avascular proximal poles, as well as complex defects of the clavicle, humerus, ulna, metacarpal or in the head and neck region, and the revascularization of aseptic bone necrosis, e.g. of the lunate in Kienböck’s disease [1], [3], [5], [6], [7]. The exact vascular anatomy of this very versatile harvest site for microsurgical bone grafts has been studied by Yamamoto et al. [8]. Compared to other bony donor sites (e.g. fibula, iliac crest, scapula), the femur graft provides the advantages of low morbidity and perfusion through a thin periosteal layer which avoids interfering soft tissue bulk. It meets the requirements for vascularization of the underperfused environment and stable support of the augmented bone area [3], [5]. Vascularized bone grafts may become hypertrophic, enhance normal fracture healing and thus adapt to stress physiologically better and achieve earlier bony stability [3], [6]. The femur graft is particularly dense bone, it can be well-formed and fitted in irregular defects. Disadvantage include complicated harvest in cases of variations of the vascular supply. Microsurgical expertise...
is essential in this technically demanding and time-consuming procedure [6]. The combination of surgery on upper and lower extremity requires general anesthesia. Rarely, postoperative complications occur, such as dysesthesia in the area of the saphenous nerve or knee pain during flexion which usually disappears after 4–6 weeks [1] – this was not an issue in our patient. Hand therapy can be tedious. The reconstruction of severe bone defects by vascularized bone grafts usually requires osteosynthesis fixation to achieve optimal motion and strength by early and intensive exercise. As a special feature in our patient, plate fixation for stabilization of the bone block could be used simultaneously for motion-preserving partial fusion between radius, scaphoid and lunate. Notably, range of wrist motion was severely impaired due to pain and instability preoperatively, yet increased in all planes after bony stabilization despite limited wrist RSL fusion.

Conclusion

A bone defect in the distal radius after fracture with planned RSL fusion is another indication for the use of a microsurgical bone graft from the medial femoral condyle, which allows stable bone reconstruction and a valuable partial preservation of wrist mobility.

Notes

Competing interests

The authors declare that they have no competing interests.

References


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